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(54) **METHODS AND DEVICES FOR MINIMALLY-INVASIVE DELIVERY OF RADIATION TO THE EYE**

(71) Applicant: **SALUTARIS MEDICAL DEVICES, INC.**, Tucson, AZ (US)

(72) Inventors: **Russell J. Hamilton**, Tucson, AZ (US); **Laurence J. Marsteller**, Tucson, AZ (US); **Michael Voevodsky**, Grand Rapids, MI (US); **Samuel Hyman**, Tucson, AZ (US); **Timothy Shriver**, Vail, AZ (US)

(73) Assignee: **SALUTARIS MEDICAL DEVICES, INC.**, Tucson, AZ (US)

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See application file for complete search history.

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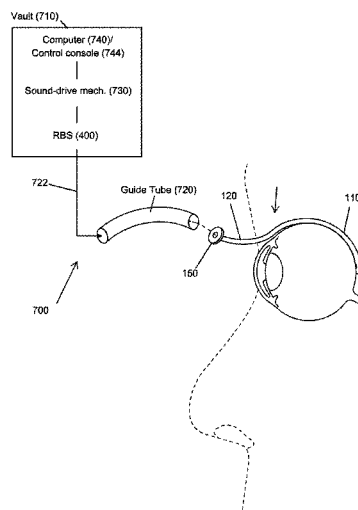
Primary Examiner — Catherine B Kuhlman

(74) *Attorney, Agent, or Firm* — Nguyen & Tarbet, LLC

(57) **ABSTRACT**

Methods and devices for minimally-invasive delivery of radiation to the eye (such as the posterior portion of the eye) including cannulas with afterloading systems for introducing radionuclide brachytherapy sources to the cannulas, for example following insertion and positioning of the cannulas. The afterloaders may house the radionuclide brachytherapy source in a vault and connect to the cannula via a guide tube. The afterloaders can advance and retract the source and ensure accurate placement of the source within the cannula.

20 Claims, 5 Drawing Sheets



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is a continuation-in-part of application No. 13/742,823, filed on Jan. 16, 2013, now Pat. No. 8,597,169, which is a continuation of application No. 12/497,644, filed on Jul. 3, 2009, now abandoned, which is a continuation-in-part of application No. 12/350,079, filed on Jan. 7, 2009, now Pat. No. 8,430,804, application No. 14/011,516, which is a continuation-in-part of application No. 13/111,780, filed on May 19, 2011, now Pat. No. 8,608,632, and a continuation-in-part of application No. 12/497,644, filed on Jul. 3, 2009, now abandoned, which is a continuation-in-part of application No. 12/350,079, filed on Jan. 7, 2009, now Pat. No. 8,430,804, application No. 14/011,516, which is a continuation-in-part of application No. 12/917,044, filed on Nov. 1, 2010, now abandoned, application No. 14/011,516, which is a continuation-in-part of application No. 13/111,765, filed on May 19, 2011, now Pat. No. 8,602,959, application No. 14/011,516, which is a continuation-in-part of application No. 13/953,528, filed on Jul. 29, 2013.

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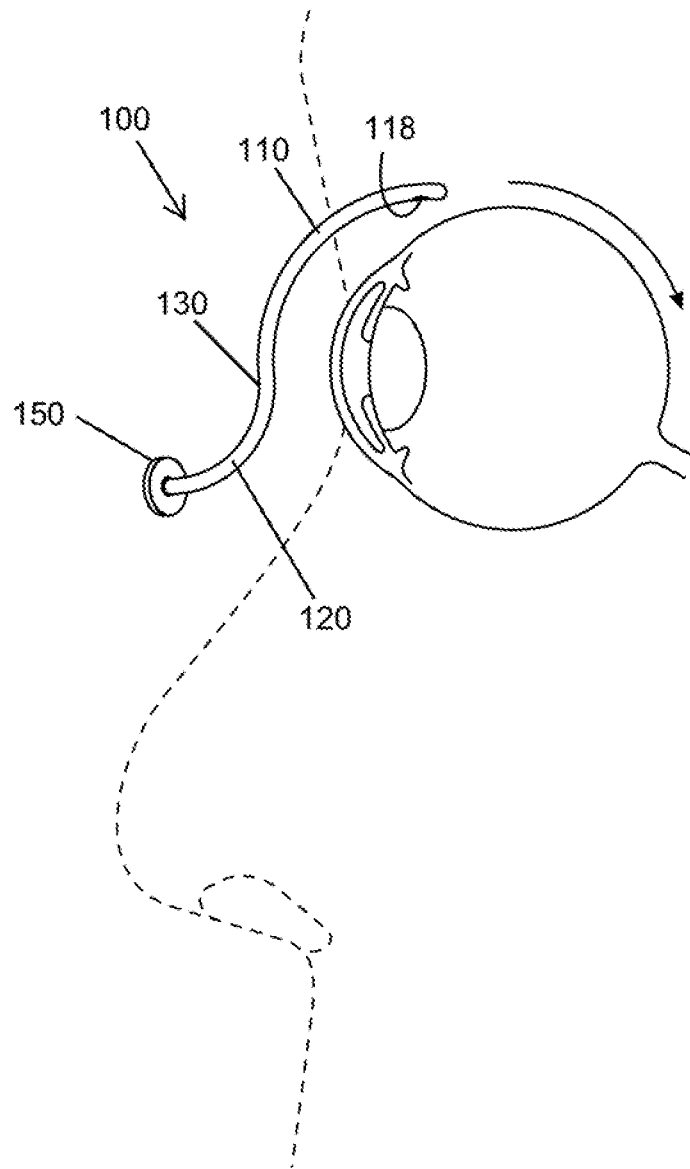


FIG. 1

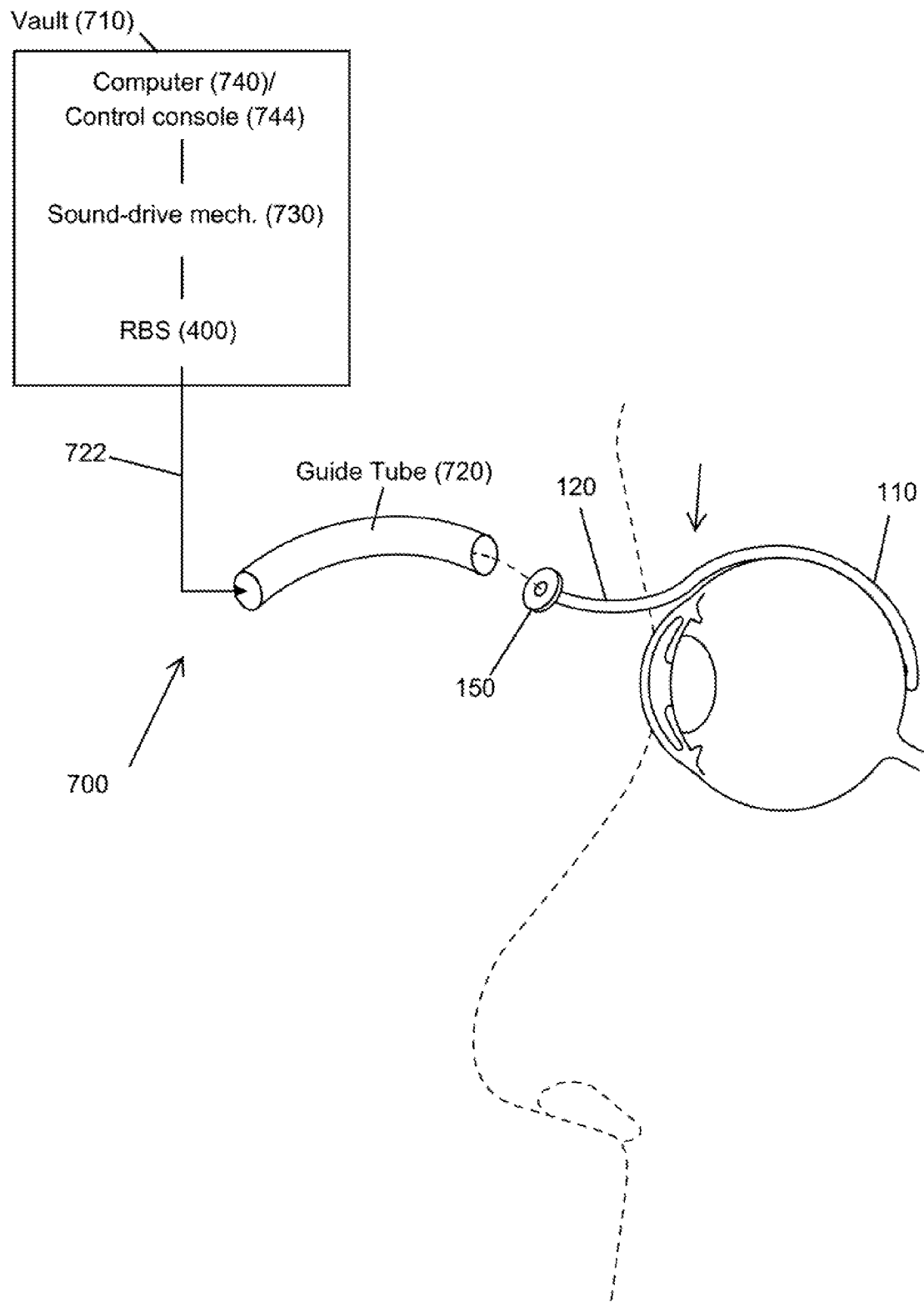


FIG. 2

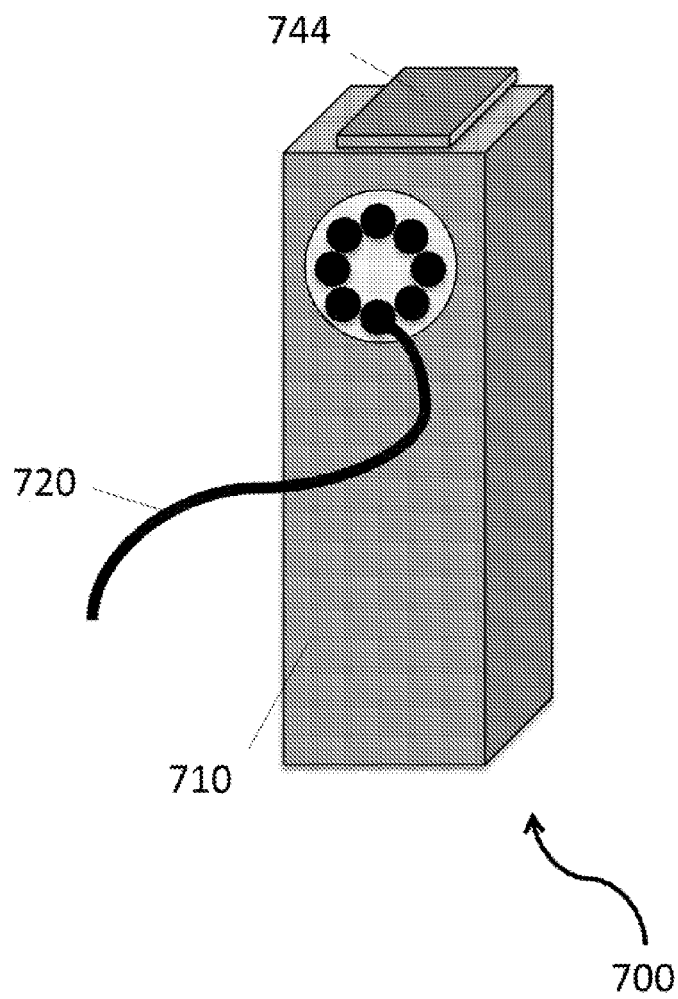


FIG. 3

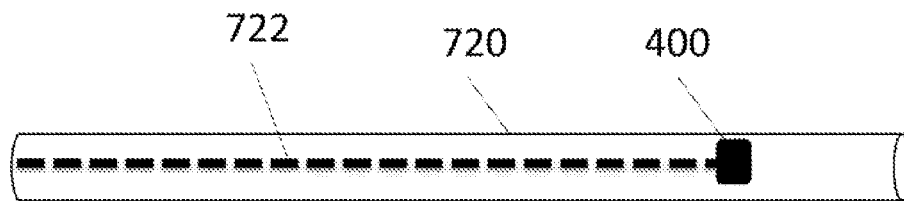
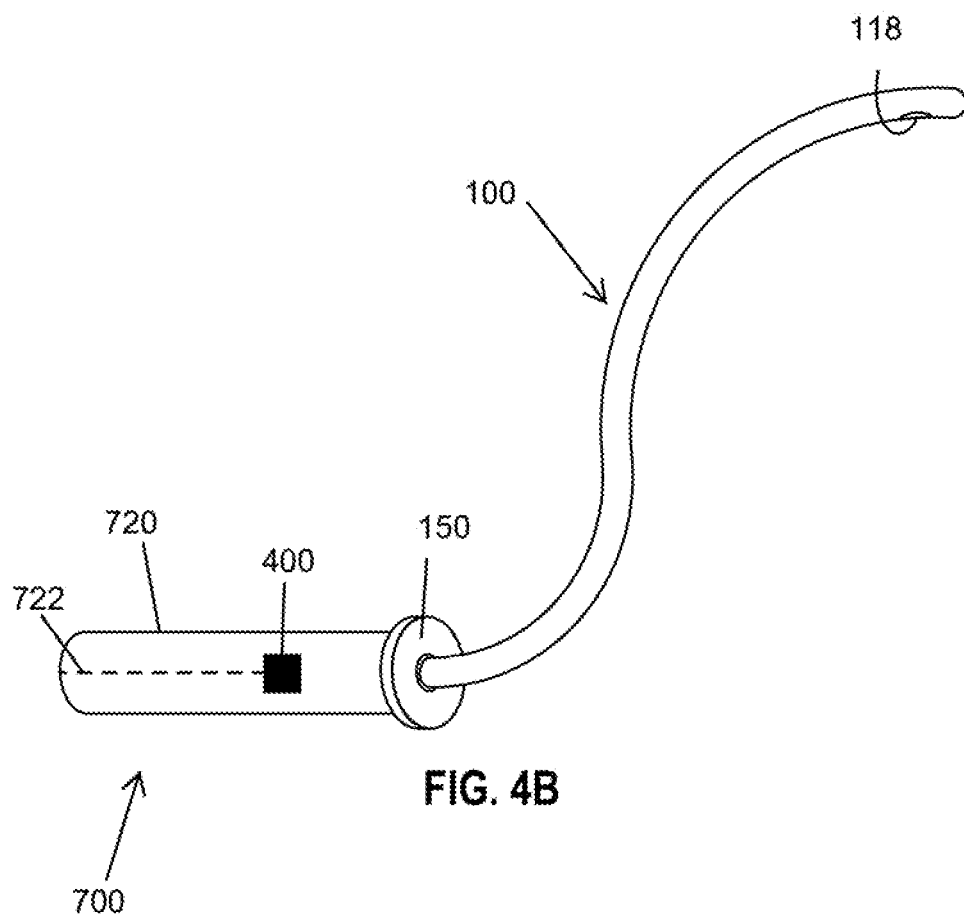


FIG. 4A





METHODS AND DEVICES FOR MINIMALLY-INVASIVE DELIVERY OF RADIATION TO THE EYE

CROSS REFERENCE

This application claims priority to U.S. patent application Ser. No. 13/872/941, filed Apr. 29, 2013, which is a division of U.S. patent application Ser. No. 12/350,079, filed Jan. 7, 2009, which is a non-provisional of U.S. Provisional Application No. 61/010,322, filed Jan. 7, 2008, U.S. Provisional Application No. 61/033,238, filed Mar. 3, 2008, U.S. Provisional Application No. 61/035,371, filed Mar. 10, 2008, and U.S. Provisional Application No. 61/047,693, filed Apr. 24, 2008, the specification(s) of which is/are incorporated herein in their entirety by reference.

This application also claims priority to U.S. patent application Ser. No. 13/742,823, filed Jan. 16, 2013, which is a continuation of U.S. patent application Ser. No. 12/497,644, filed Jul. 3, 2009, which is a continuation-in-part of U.S. patent application Ser. No. 12/350,079, filed Jan. 7, 2009, which is a non-provisional of U.S. Provisional Application No. 61/010,322, filed Jan. 7, 2008, U.S. Provisional Application No. 61/033,238, filed Mar. 3, 2008, U.S. Provisional Application No. 61/035,371, filed Mar. 10, 2008, and U.S. Provisional Application No. 61/047,693, filed Apr. 24, 2008, the specification(s) of which is/are incorporated herein in their entirety by reference.

This application also claims priority to U.S. patent application Ser. No. 13/111,780, filed May 19, 2011, which is a non-provisional of U.S. Provisional Application No. 61/347,226, filed May 21, 2010; and a continuation-in-part of U.S. patent application Ser. No. 12/497,644, filed Jul. 3, 2009, which is a continuation-in-part of U.S. patent application Ser. No. 12/350,079, filed Jan. 7, 2009, which is a non-provisional of U.S. Provisional Application No. 61/010,322, filed Jan. 7, 2008, U.S. Provisional Application No. 61/033,238, filed Mar. 3, 2008, U.S. Provisional Application No. 61/035,371, filed Mar. 10, 2008, and U.S. Provisional Application No. 61/047,693, filed Apr. 24, 2008, the specification(s) of which is/are incorporated herein in their entirety by reference.

This application also claims priority to U.S. patent application Ser. No. 12/917,044, filed Nov. 1, 2010, which is a non-provisional of U.S. Provisional Application No. 61/257,232, filed Nov. 2, 2009 and U.S. Provisional Application No. 61/376,115, filed Aug. 23, 2010, the specification(s) of which is/are incorporated herein in their entirety by reference.

This application also claims priority to U.S. patent application Ser. No. 13/111,765, filed May 19, 2011, which is a non-provisional of U.S. Provisional Application No. 61/347,233, filed May 21, 2010, the specification(s) of which is/are incorporated herein in their entirety by reference.

This application also claims priority to U.S. patent application Ser. No. 13/953,528, filed Jul. 29, 2013, which is a non-provisional of U.S. Provisional Application No. 61/676,783, filed Jul. 27, 2012, the specification(s) of which is/are incorporated herein in their entirety by reference.

FIELD OF THE INVENTION

The present invention relates to methods and devices for introducing radiation to the eye, e.g., the posterior portion of the eye, for treating and/or managing eye conditions including but not limited to macular degeneration.

BACKGROUND OF THE INVENTION

The present invention features methods and devices for minimally-invasive delivery of radiation to the eye, e.g., the

posterior portion of the eye. For example, the present invention features cannulas and afterloading systems (e.g., remote afterloading systems) for introducing radionuclide brachytherapy sources (RBS) to the cannulas for irradiating targets (e.g., targets of the eye). The RBS may be, for example, introduced into the cannula via an afterloading system following cannula insertion and positioning.

Any feature or combination of features described herein are included within the scope of the present invention provided that the features included in any such combination are not mutually inconsistent as will be apparent from the context, this specification, and the knowledge of one of ordinary skill in the art. Additional advantages and aspects of the present invention are apparent in the following detailed description and claims.

SUMMARY OF THE INVENTION

The present invention features methods of irradiating a target of an eye in a patient. In some embodiments, the method comprises (a) inserting a cannula into a potential space between a sclera and a Tenon's capsule of the eye of the patient, wherein the cannula is operatively connected to an afterloading system having a radionuclide brachytherapy source (RBS); (b) positioning the RBS over the target; (c) irradiating the target with the RBS; and (d) removing the cannula.

In some embodiments, the method comprises (a) inserting a cannula into a potential space between a sclera and a Tenon's capsule of the eye of the patient, wherein the cannula is operatively connected to an afterloading system having a radionuclide brachytherapy source (RBS); (b) placing a distal portion of the cannula on or near the sclera and positioning a treatment position(s) of the cannula (e.g., of the distal portion of the cannula) near the target; (c) advancing the RBS from the afterloading system through the cannula (100) to the treatment position(s) in the distal portion of the cannula; (d) exposing the target to the RBS; (e) retracting the RBS; and (f) removing the cannula.

In some embodiments, the method comprises (a) inserting a cannula into a potential space between a sclera and a Tenon's capsule of the eye of the patient; (b) placing a distal portion of the cannula on or near the sclera and positioning a treatment position(s) of the distal portion of the cannula near the target; (c) operatively connecting an afterloading system having a radionuclide brachytherapy source (RBS) to the cannula; (d) advancing the RBS from the afterloading system through the cannula to the treatment position(s) in the distal portion of the cannula; (e) exposing the target to the RBS; and (f) retracting the RBS; and (g) removing the cannula.

In some embodiments, the afterloading system comprises (a) a vault for storage of the RBS, wherein the RBS is attached to an advancing means; (b) a guide tube extending from the vault, wherein the guide tube is removably attachable to the cannula; and (c) a source-drive mechanism operatively connected to the advancing means, wherein the source-drive mechanism advances the RBS through the guide tube to the treatment position(s) in the cannula. In some embodiments, the source-drive mechanism retracts the RBS from the treatment position(s).

In some embodiments, the source-drive mechanism comprises a motor. In some embodiments, the motor comprises drive rollers or belts. In some embodiments, the source-drive mechanism is operatively connected to a computer or other controller. In some embodiments, the computer or other controller is operatively connected to a control console, the control console allows for manipulation of the computer or other

controller. In some embodiments, the afterloading system measures dwell time of the RBS in the treatment position(s).

In some embodiments, the afterloading system moves the RBS from the vault to the treatment position(s) at a rate of between about 0.01 m/s to about 4 m/s. In some embodiments, the afterloading system moves the RBS from the vault to the treatment position(s) at a rate of between about 2 m/s. In some embodiments, the RBS is a high-dose-rate (HDR) source. In some embodiments, the RBS provides a dose rate of between about 2 to 10 Gy/min to the target. In some embodiments, the RBS provides a dose rate of between about 1 to 10 Gy/min to the target. In some embodiments, the RBS provides a dose rate of between about 2 to 6 Gy/min to the target. In some embodiments, the RBS provides a dose rate of about 4.4 Gy/min to the target.

In some embodiments, the cannula comprises a distal portion and a proximal portion connected by an inflection point, the distal portion has a radius of curvature between about 9 to 15 mm and an arc length between about 25 to 35 mm and the proximal portion has a radius of curvature between about an inner cross-sectional radius of the cannula and about 1 meter. In some embodiments, the cannula is flexible. In some embodiments, the cannula has a fixed shape.

In some embodiments, the afterloader system is operatively connected to the cannula after the cannula is positioned in between the Tenon's capsule and sclera. In some embodiments, the afterloader system is operatively connected to the cannula before the cannula is positioned in between the Tenon's capsule and sclera. In some embodiments, both (a) the afterloader system is operatively connected to the cannula and (b) the RBS is advanced before the cannula is positioned in between the Tenon's capsule and sclera.

The present invention also features brachytherapy systems. In some embodiments, the brachytherapy system comprises (a) a cannula for insertion into a potential space between a sclera and a Tenon's capsule of an eye of a patient; and (b) an afterloading system operatively connected to the cannula. In some embodiments, the afterloading system comprises: a vault for storage of a radionuclide brachytherapy source (RBS), wherein the RBS is attached to an advancing means; a guide tube extending from the vault, wherein the guide tube is removably attachable to the cannula; and a source-drive mechanism operatively connected to the advancing means, wherein the source-drive mechanism advances the RBS through the guide tube to the treatment position(s) in the cannula. In some embodiments, the afterloader system is attached to the cannula via a connector.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an in-use view of a cannula of the present invention.

FIG. 2 shows a schematic view of an afterloading system attachable to a cannula.

FIG. 3 shows a schematic view of an afterloading system of the present invention. Afterloading systems are well known to one of ordinary skill in the art. The present invention is not limited to the afterloading systems described herein.

FIG. 4A shows the advancing means and RBS within the guide tube.

FIG. 4B shows the guide tube connecting to the cannula.

DESCRIPTION OF PREFERRED EMBODIMENTS

Following is a list of elements corresponding to a particular element referred to herein:

100 cannula
110 distal portion of cannula
118 treatment position
120 proximal portion of cannula
130 inflection point of cannula
150 connector (optional)
400 radionuclide brachytherapy source (RBS)
700 afterloading system
710 vault
720 guide tube
722 advancing means (e.g., guide wire)
730 source-drive mechanism
732 motor
740 computer (e.g., microprocessor)
744 control console

Referring now to FIG. 1-4, the present invention features methods and devices for minimally-invasive delivery of radiation to the eye, e.g., the posterior portion of the eye. For example, the present invention features afterloading systems (700) (e.g., remote afterloading systems) for introducing a radionuclide brachytherapy source (RBS) (400) to a cannula (100). The cannula (100) may be adapted for insertion into a potential space between the sclera and the Tenon's capsule of the eye of a patient.

The present methods and devices may be effective for treating and/or managing a condition (e.g., an eye condition). For example, the present methods and devices may be used to treat and/or manage wet (neovascular) age-related macular degeneration. The present methods are not limited to treating and/or managing wet (neovascular) age-related macular degeneration. For example, the present methods may also be used to treat and/or manage conditions including macular degeneration, abnormal cell proliferation, choroidal neovascularization, retinopathy (e.g., diabetic retinopathy, vitreoretinopathy), macular edema, and tumors (e.g., intra ocular melanoma, choroidal melanoma, retinoblastoma).

Cannula

As shown in FIG. 1, the cannula (100) comprises a distal portion (110) and a proximal portion (120) connected by an inflection point (130). The distal portion (110) is generally for placement around a portion of the globe of the eye. In some embodiments, the distal portion (110) has a radius of curvature between about 9 to 15 mm and an arc length between about 25 to 35 mm. In some embodiments, the proximal portion (120) has a radius of curvature between about an inner cross-sectional radius of the cannula (100) and about 1 meter. The cannula (100), or a portion thereof, may be flexible, fixed-shape, or a combination thereof. The cannula (100) is not limited to the aforementioned dimensions and configurations.

The cannula (100) may be operatively connected to an afterloading system (700) having a radionuclide brachytherapy source (RBS) (400). The afterloading system (700) can deliver the RBS (400) to the cannula (100) (e.g., to a treatment position (118) of the cannula (100), to at least one treatment position, to one or more treatment positions, etc.). For example, the afterloading system (700) can direct the RBS (400) to a position within the cannula (100) (e.g., a treatment position (118), at least one treatment position, one or more treatment positions, etc.) such that the RBS (400) is over a target. The RBS (400) can then irradiate the target for a length of time desired. The afterloading system (700) may also function to remove the RBS (400) from the position within the cannula (e.g., the treatment position(s) (118)) and from the cannula (100) altogether. For example, the afterloading system (700) may retract the RBS (400) to its starting position outside of the cannula (100).

The cannula (100) may comprise one or more treatment positions (118). The afterloading system (700) may function to deliver one or more RBSs (400) to one or more treatment positions (118).

In some embodiments, the cannula (100) is inserted, e.g., into the potential space between the sclera and the Tenon's capsule, and is positioned appropriately prior to attachment of the afterloading system (700). For example, the distal portion (110) of the cannula is placed on or near the sclera and the treatment position(s) (118) of the cannula (100) (e.g., in the distal portion (110)) or treatment position(s), is positioned near the target. Following placement and positioning of the cannula, the afterloading system (700) may be connected to the cannula. In some embodiments, the cannula (100) and the afterloading system (700) are connected prior to insertion of the cannula (100), e.g., into the potential space between the sclera and the Tenon's capsule.

Afterloading System

The afterloading system (700) may allow for accurate placement of the RBS (400), e.g., at the treatment position(s) (118) within the cannula (100). Afterloading systems (700) are well known to one of ordinary skill in the art and any appropriate afterloading system (700) may be utilized. For example, in some embodiments, the afterloading system (700) comprises a vault (710) for temporary housing of the RBS (400). The RBS (400) may be attached to an advancing means (722) (e.g., a guide wire). In some embodiments, the RBS (400) may be incorporated into the advancing means (722) (e.g., guide wire). The advancing means (722) (e.g., guide wire) may be constructed from any appropriate material including but not limited to nitinol and stainless steel. A guide tube (720) extends from the vault (710) and is connected to the cannula (100). In some embodiments, the guide tube (720) connects, e.g., removably connects, to the cannula (100) via a connector (150). In some embodiments, the connector (150) is disposed on the cannula (100), e.g., on the proximal portion (120) of the cannula (100). The advancing means (722) directs the RBS (400) through the guide tube (720), e.g., the advancing means (722) may be disposed in at least a portion of the guide tube (720).

The afterloading system (700) comprises a source-drive mechanism (730) operatively connected to the advancing means (722) (e.g., guide wire). The source-drive mechanism (730) functions to advance the advancing means (722) (e.g., guide wire) and RBS (400) through the guide tube (720) to the treatment position(s) (118) in the cannula (100). In some embodiments, the source-drive mechanism (730) comprises a motor (732). In some embodiments, the motor (732) comprises drive rollers or belts.

In some embodiments, the afterloading system (700) comprises a computer (740) (e.g., a microprocessor) or other controller (e.g., an analog or a mechanical control system). The motor (732) and/or source-drive mechanism (730) may be operatively connected to the computer (740) or other controller. In some embodiments, the computer (740) or other controller is operatively connected to a control console (744). The control console (744) allows for manipulation of the computer (740) or other controller. For example, the control console (744) may allow for programming of the afterloading system (700), e.g., dwell time of the RBS (400) in the treatment position(s) (118), speed of delivery of the RBS (400), etc. In some embodiments, the afterloading system (700) moves the RBS (400) from the vault (710) to the treatment position(s) (118) at a rate of between about 0.01 m/s (1 cm/s) to about 4 m/s. In some embodiments, the afterloading system (700) moves the RBS (400) from the vault (710) to the treatment position(s) (118) at a rate of about 2 m/s.

The afterloading system (700) may measure various parameters of the treatment. For example, in some embodiments, the afterloading system (700) measures dwell time of the RBS (400) in the treatment position(s) (118).

In some embodiments, the guide tube (720) is constructed from a material that provides some shielding from the radiation emitted from the RBS (400) as it travels through the guide tube (720).

In some embodiments, the afterloader system (700) further comprises a selector, for example for treatments that require multiple applicators or cannulas (100). The selector may provide multiple channels, e.g., between 1 to 10 channels, between 2 to 10 channels, between 2 to 20 channels, between 16 to 24 channels, between 18 to 24 channels, more than 24 channels, etc. The selector may facilitate the movement (e.g., entry, transfer) of the RBS (400) through multiple applicators (e.g., cannulas (100)), if necessary.

Radionuclide Brachytherapy Source

The methods and devices of the present invention may feature any appropriate RBS (400). In some embodiments, the RBS (400) is a high-dose-rate (HDR) source. In some embodiments, the RBS (400) is a low-dose-rate (LDR) source. In some embodiments, the RBS (400) is a pulsed-dose-rate (PDR) source. In some embodiments, the RBS (400), e.g., HDR source, delivers a dose rate greater than 100 cGy per minute for a length of time. However the present invention is not limited to a HDR source that delivers a dose rate greater than 100 cGy per minute. In some embodiments, the RBS (400) provides a dose rate of between about 2 to 10 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of between about 1 to 10 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of between about 2 to 6 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of about 4.4 Gy/min to the target. In some embodiments, a LDR source provides a dose rate of less than about 2 Gy/hour. In some embodiments, a medium-dose-rate (MDR) source provides a dose rate of between about 2 to 12 Gy/hour. In some embodiments, a HDR source provides a dose rate of greater than about 12 Gy/hour.

In some embodiments, the RBS (400) provides a dose rate of greater than about 10 Gy/min. In some embodiments, the RBS (400) provides a dose rate of greater than about 11 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of greater than about 12 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of greater than about 13 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of greater than about 14 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate of greater than about 15 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 10 to 15 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 15 to 20 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 20 to 30 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 30 to 40 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 40 to 50 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 50 to 60 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 60 to 70 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 70 to 80 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 80 to 90 Gy/min. In some embodiments, the RBS (400) provides a dose rate between about 90 to 100 Gy/min. In some embodiments, the RBS (400) provides a dose rate of greater than 100 Gy/min.

In some embodiments, the RBS (400) provides a dose rate between about 15 to 20 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 20 to 25 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 25 to 30 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 30 to 35 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 35 to 40 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 40 to 50 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 50 to 60 Gy/min to the target. In some embodiments, the RBS provides a dose rate between about 60 to 70 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 70 to 80 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 80 to 90 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate between about 90 to 100 Gy/min to the target. In some embodiments, the RBS (400) provides a dose rate greater than about 100 Gy/min to the target.

As used herein, the term "about" refers to plus or minus 10% of the referenced number.

Various modifications of the invention, in addition to those described herein, will be apparent to those skilled in the art from the foregoing description. Such modifications are also intended to fall within the scope of the appended claims. Each reference cited in the present application is incorporated herein by reference in its entirety.

Although there has been shown and described the preferred embodiment of the present invention, it will be readily apparent to those skilled in the art that modifications may be made thereto which do not exceed the scope of the appended claims. Therefore, the scope of the invention is only to be limited by the following claims. Reference numbers recited in the claims are exemplary and for ease of review by the patent office only, and are not limiting in any way. In some embodiments, the figures presented in this patent application are drawn to scale, including the angles, ratios of dimensions, etc. In some embodiments, the figures are representative only and the claims are not limited by the dimensions of the figures. In some embodiments, descriptions of the inventions described herein using the phrase "comprising" includes embodiments that could be described as "consisting of", and as such the written description requirement for claiming one or more embodiments of the present invention using the phrase "consisting of" is met.

The reference numbers recited in the below claims are solely for ease of examination of this patent application, and are exemplary, and are not intended in any way to limit the scope of the claims to the particular features having the corresponding reference numbers in the drawings.

What is claimed is:

1. A method of irradiating a target of an eye in a patient, said method comprising:

- (a) inserting a cannula (100) into a potential space between a sclera and a Tenon's capsule of the eye of the patient, the cannula (100) is operatively connected to an afterloading system (700) having a radionuclide brachytherapy source (RBS) (400);
- (b) placing a distal portion (110) of the cannula (100) on or near the sclera and positioning a treatment position (118) of the distal portion (110) of the cannula (100) near the target;
- (c) advancing the RBS (400) from the afterloading system (700) through the cannula (100) to the treatment position (118) in the distal portion (110) of the cannula (110);

- (d) exposing the target to the RBS (400);
- (e) retracting the RBS (400); and
- (f) removing the cannula (100).

2. The method of claim 1, wherein the afterloading system (700) comprises:

- (a) a vault (710) for storage of the RBS (400), wherein the RBS (400) is attached to an advancing means (722);
- (b) a guide tube (720) extending from the vault (710), the guide tube (720) is removably attachable to the cannula (100); and
- (c) a source-drive mechanism (730) operatively connected to the advancing means (722), wherein the source-drive mechanism (730) advances the RBS (400) through the guide tube (720) to the treatment position (118) in the cannula (100) and retracts the RBS (400) from the treatment position (118).

3. The method of claim 2, wherein the source-drive mechanism (730) is operatively connected to a computer (740) or other control system.

4. The method of claim 3, wherein the computer (740) or other control system is operatively connected to a control console (744), the control console (744) allows for manipulation of the computer (740) or other control system.

5. The method of claim 1, wherein the afterloading system (700) measures dwell time of the RBS (400) in the treatment position (118).

6. The method of claim 1, wherein the RBS (400) provides a dose rate of between about 1 to 10 Gy/min to the target.

7. The method of claim 1, wherein the cannula (100) comprises a distal portion (110) and a proximal portion (120) connected by an inflection point (130), the distal portion (110) has a radius of curvature between about 9 to 15 mm and an arc length between about 25 to 35 mm and the proximal portion (120) has a radius of curvature between about an inner cross-sectional radius of the cannula (100) and about 1 meter.

8. The method of claim 1, wherein the afterloader system (700) is operatively connected to the cannula (100) after the cannula (100) is positioned in between the Tenon's capsule and sclera.

9. The method of claim 1, wherein the afterloader system (700) is operatively connected to the cannula (100) before the cannula is positioned in between the Tenon's capsule and sclera.

10. The method of claim 1, wherein both (a) the afterloader system (700) is operatively connected to the cannula (100) and (b) the RBS (400) is advanced before the cannula (100) is positioned in between the Tenon's capsule and sclera.

11. A method of irradiating a target of an eye in a patient, said method comprising:

- (a) inserting a cannula (100) into a potential space between a sclera and a Tenon's capsule of the eye of the patient;
- (b) placing a distal portion (110) of the cannula (100) on or near the sclera and positioning a treatment position (118) of the distal portion (110) of the cannula (100) near the target;
- (c) operatively connecting an afterloading system (700) having a radionuclide brachytherapy source (RBS) (400) to the cannula (100);
- (d) advancing the RBS (400) from the afterloading system (700) through the cannula (100) to the treatment position (118) in the distal portion (110) of the cannula (110);
- (e) exposing the target to the RBS (400); and
- (f) retracting the RBS (400); and
- (g) removing cannula (100).

12. The method of claim 11, wherein the afterloading system (700) comprises:

- (a) a vault (710) for storage of the RBS (400), wherein the RBS (400) is attached to an advancing means (722);
- (b) a guide tube (720) extending from the vault (710), the guide tube (720) is removably attachable to the cannula (100); and
- (c) a source-drive mechanism (730) operatively connected to the advancing means (722), wherein the source-drive mechanism (730) advances the RBS (400) through the guide tube (720) to the treatment position (118) in the cannula (100) and retracts the RBS (400) from the treatment position (118).

13. The method of claim 12, wherein the source-drive mechanism (730) is operatively connected to a computer (740) or other control system.

14. The method of claim 13, wherein the computer (740) or other control system is operatively connected to a control console (744), the control console (744) allows for manipulation of the computer (740) or other control system.

15. The method of claim 11, wherein the afterloading system (700) measures dwell time of the RBS (400) in the treatment position (118).

16. The method of claim 11, wherein the RBS (400) provides a dose rate of between about 1 to 10 Gy/min to the target.

17. The method of claim 11, wherein the cannula (100) comprises a distal portion (110) and a proximal portion (120) connected by an inflection point (130), the distal portion (110) has a radius of curvature between about 9 to 15 mm and an arc length between about 25 to 35 mm and the proximal

portion (120) has a radius of curvature between about an inner cross-sectional radius of the cannula (100) and about 1 meter.

18. A method of irradiating a target of an eye in a patient, said method comprising:

- (a) inserting a cannula (100) into a potential space between a sclera and a Tenon's capsule of the eye of the patient, the cannula (100) is operatively connected to an afterloading system (700) having a radionuclide brachytherapy source (RBS) (400);
- (b) positioning the RBS (400) over the target;
- (c) irradiating the target with the RBS (400); and
- (d) removing the cannula (100).

19. The method of claim 18, wherein the afterloading system (700) comprises:

- (a) a vault (710) for storage of the RBS (400), wherein the RBS (400) is attached to an advancing means (722);
- (b) a guide tube (720) extending from the vault (710), the guide tube (720) is removably attachable to the cannula (100); and
- (c) a source-drive mechanism (730) operatively connected to the advancing means (722), wherein the source-drive mechanism (730) advances the RBS (400) through the guide tube (720) to a treatment position (118) in the cannula (100).

20. The method of claim 19, wherein the source-drive mechanism (730) is operatively connected to a computer (740) or other control system.

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